

BIOLOGICAL NOTES ON SOME WESTERN CICADAS

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Special attention was given to the collecting and study of cicadas during the biological field trip from Kansas to California and return in the summer of 1929. The ear of each member of the party was trained to listen for their song and, when it was heard, every effort was made to secure specimens and notes on the songs, nesting habits, general habitat, etc. Cicadas were collected in all sorts of habitats: in the desert at a temperature of 120 degrees, below sea-level in Salton Sea valley, where the dust was six inches deep in the fields, on precipitous cliffs, on mountain sides where chapparal was almost impenetrable, among cacti, in huge trees, and in holes in the ground.

In all, 831 specimens were taken belonging to thirty-one species and varieties. While only one variety was new to science, this series added twelve species and varieties to the Snow collection and completed the series of four specimens in seven other cases. The authors are deeply indebted to Mr. Wm. T. Davis, Staten Island, N. Y., for making all the determinations.

The following notes are arranged in the order in which the species were taken and hence present a chronological arrangement but no sequence at all as to relationship of species.

Okanagana bella var. *rubrocaudata* Davis

The first cicadas heard were at Raton Pass, N. M., June 26. *O. bella* var. *rubrocaudata* Davis was singing in pine trees in the forenoon. Five males and one female were taken. The specimens were not numerous and were located with difficulty.

Platypedia putnami Uhler

A mating pair of *P. putnami* Uhl. was taken with the hands from a scrub oak shrub in this same locality. No other specimens were heard or seen.

Cacama valvata Uhler

The party next found a large brood of *C. valvata* Uhl., June 28, on the steeply sloping side of the mesa about thirty miles west of Santa Fe, N. M. Stopping near the foot of the hairpin trail leading off of the mesa, everyone collected for an hour in a habitat of cane cactus sparsely set among large boulders. From one to many cicadas could be located on each cactus and it was soon discovered that they could be taken with the fingers if one moved slowly and steadily upon them. They usually were found sitting on the thorns. In only one case was one observed in such position that it was thought to be feeding on the green stalk. The males, which predominated in numbers, sang with a high pitched, even, metallic zing. The females were ovipositing almost entirely in the very dry dead skeletonized stems of the cactus. Very rarely was green material used. A great many nests were collected and several large series were sent to the laboratory at Lawrence for further observation. There were usually four or five eggs in a nest in irregular arrangement. Quite often the stems were so filled with nests that it was difficult to determine where one nest ended and another began. The entire outer surfaces of the stems were roughened by the torn tissue at the nest openings. There were many emergence holes in the dry ground between the boulders and numerous exuvia were found clinging to rocks or cactus thorns. Forty-nine males and thirteen females were taken. While the vegetation here was exclusively cane cacti, *Cacama valvata* Uhl. was taken six miles farther southwest in a habitat of sage brush, yucca, and cedar where there was no cactus.

Again, near Ashfork, in the north edge of Yavapai Co., Ariz., seven males and five females of this same species were taken in a habitat of small cedars on the first of July. The striking difference in the brood here and that studied in New Mexico was that these were exceedingly wild. The specimens were easily spotted perhaps twenty feet away as they perched on the edge of small cedar twigs, but the greatest caution was necessary to take them with nets. The collectors soon learned to circle the tree and approach as near as possible to the cicada before com-

ing in sight. From this ambush a quick stroke of the net was sometimes effective. When collecting began at 4 P. M. a number of males were singing. The song was from six to nine seconds duration with the rest between songs varying from eight to fifteen seconds. The rate of vibration usually became slower toward the end of the song. Within half an hour after collecting began, all the songs had ceased and they did not begin again while the party remained.

One female was observed and photographed ovipositing in a cedar twig three-sixteenths of an inch in diameter six inches from the tip. She flew before a picture at close range could be taken. She had made eight nests in a straight line sitting with her head toward the tip of the twig. The nests each contained five eggs, inserted two, two, one from the bottom up, slightly mismatched. The nest opening was left jagged. The eggs shriveled when the host withered.

A cicada was heard on Yarnell Hill, Ariz., which was thought to be this species but no specimens were taken.

The nests of eggs in cane cactus were placed over live cages in Lawrence, Kansas. When they were examined September 12, the eggs were found to be pink and the dark eyespots and tarsal claws were plainly visible. On September 13, a stem was immersed in water and placed in the morning sunlight. In half an hour the nymphs were emerging rapidly. In an hour the hatch for the day was completed. Later the stems were wet in the afternoon with no result. September 17, they were left in a cold rain during the early morning. About eight A. M., with the temperature fifty-two degrees, the nymphs began emerging. September 20, forty-six nymphs emerged following immersion of the stem. Subsequent wettings brought out two or three nymphs. The egg stage, under conditions of Kansas climate, appears to be nearly three months.

The observations on these relatively few nests of eggs indicated that the eggs hatched only in the presence of moisture and reduced temperature. This seems not an illogical phenomenon for surely the fragile nymphs would be helpless in the normal excessive heat and drouth of the New Mexico desert and probably their only chance for life is to wait until one of the rare

desert storms wets the stem and the ground and reduces the temperature.

The notes on the eggs of the two different broods offer interesting problems. Only one instance has been found in the study of Kansas cicadas where the eggs of a species, which usually will withstand the wilting of the host plant, wilt in a special host. This instance was where a female *Tibicen dorsata*, caged over a small black walnut tree, oviposited in the stems of the deciduous leaves. When the leaves withered, the eggs did, also. In this case the conditions were considered to be so abnormal that no special importance was attached to the phenomena. In the case of *Cacama valvata*, however, both ovipositions were made under natural conditions. In both instances the female had a choice of live or dead material. The fact that one brood used live and the other dead is not unique. Many Kansas cicadas use live or dead tissue. But, if the eggs placed in the green cedar were dependent on the continued health of the host for their proper development, it is the first case observed where one species of cicada lays eggs in dead tissue so protected that they will mature of themselves and also in green tissue so unprotected that they will wilt when the host does. Of course, it is possible that the one female observed ovipositing in green cedar was not typical of the brood.

Diceroprocta eugraphica Davis

In a waste-land of sagebrush and cedar thirty miles east of Albuquerque, N. M., thirty-three males and twelve females of *D. eugraphica* Davis were taken June 27. Some were caught with the hands but they were more easily taken with nets. The song is a series of clicks, then a high-pitched whirr. When disturbed they flew a considerable distance, usually out of sight.

Diceroprocta cinctifera Uhler

At two P. M., on June 27, a few specimens of *D. cinctifera* Uhl. were heard singing in cottonwoods along an irrigation ditch near Isleta, New Mexico. One male was shot. The song is loud and can be heard for a considerable distance.

Okanagana magnifica Davis

On a hillside covered with pine, cedar and sage brush about fifteen miles west of Gallup, New Mexico, a large brood of *O. magnifica* Davis were singing lustily from nine to eleven A. M. on June 28. As many as thirty-six emergence holes were counted in a circle three feet in diameter and the exuvia were numerous in all the trees.

The song is not loud for so large a cicada and is of short duration, beginning and ending in a series of clicks. The song resembled somewhat that of one of the tree crickets. Many specimens were located by throwing a club into a tree and watching where the cicadas alighted when they flew. Some specimens were shot, some taken with nets, and a few stunned by hitting the limb near where they were sitting with stones and sticks with sufficient force to stun them till they fell to the ground. Mating was observed once but no eggs were found. Twenty males and twenty-three females were taken.

Tibicen duryi Davis

Along with the songs of *O. magnifica* Davis, near Gallup, New Mexico, the much longer and louder song of *T. duryi* Davis, was occasionally heard. In the two hours spent here, only seven males and one female were taken although special attention was given to them. Most of these specimens were shot because they were found too high in the trees to be reached with a net. Two specimens were taken by climbing the trees and catching them with the fingers.

This species was observed again ten miles north of Williams, Ariz., in cedar trees, July 1. Four males were taken. This brood was difficult to frighten out of trees and specimens could be taken with the fingers when they were accessible.

Again, in Zion National Park, Utah, August 12, this loud singer was found in pine trees. Here one male and one female were taken with nets and one was taken by hand, although it was necessary to climb the tree to reach them in two of the three cases.

In all three habitats this species was heard singing between eight A. M. and one P. M. In each case the song was noted to

be very loud and of long duration and resembled somewhat in rhythm the song of *Tibicen dealbata* Davis or *T. marginalis* (Walker). In none of the three habitats was there a large brood.

Tibicen bifida Davis

T. bifida Davis occurred in great numbers, June 28, in the sage brush waste from Navajo, Arizona, almost to the Painted Desert. The vegetation was growing in deep, shifting sand. They were singing lustily at twelve thirty but, though easily located, they were wary enough to be rather difficult to take. Because this species occurs and has been studied in Kansas, only eleven males and nine females were collected.

Diceroprocta apache Davis

D. apache Davis was common over large areas and occurred in a great variety of habitats, all of which were of low altitude. A number of males were heard singing in willow at eight P. M., June 30, at the bottom of the Grand Canyon. Only one was taken. A large brood occurred near Wickenburg, Ariz., July 2, in a habitat almost exclusively Palo Verde trees. Phoenix was noisy with their songs at half past six in the evening and again at ten in the morning. Near Yuma the party was welcomed when it arrived at half past seven P. M. (Rocky Mountain time), for all along the Colorado River and the irrigated section west of the river there were myriads of these noisy friends. Even in the Salton Sea valley, *D. apache* was busy singing at eight P. M., July 28, and again at seven the next morning. Exuvia clung to the wire netting around the government laboratory in Coachella. Nests of eggs were found in sunflower stalks nearby. Hundreds of adults were living in a citrus orchard a few miles north of town. As many as twenty were found in one tree. In a little group of mesquite trees a mile farther north, numbers were picked off the limbs with the fingers. Here large cicada-killers were at work but eluded the collectors.

The nests in sunflower stems were placed in a straight line from two to sixteen in a series so close together that one extends to the next. Nine or ten large eggs were placed in mismatched pairs down the stem from the nest opening. Seventy-four males and twenty-four females were taken.

Okanagana striatipes var. *beameri* Davis

About eight miles north of Williams, Arizona, numbers of a new variety of *O. striatipes* which Mr. Wm. T. Davis has described as var. *beameri* in the March, 1930, number of the JOURNAL, NEW YORK ENTOMOLOGICAL SOCIETY, were singing at eleven A. M., July 1. The habitat here was a flat, sparsely covered with very short sage brush. Again, on the same day, this variety was collected east of Ashfork, Arizona, in a similar habitat. Two exuvia were found clinging to sage brush twigs. One female was observed ovipositing in the live stem of a composite weed. The female was sitting with her head down the stem. She had made two series of nests, two nests in each series. The nests each contained six slender white eggs placed up the stem from the opening in two even rows. The eggs shriveled when the host wilted.

The song of the male was of medium pitch and of average duration.

Pacarina puella Davis

While collecting *Cacama valvata* Uhl., near Ashfork, Ariz., the party heard a male *Pacarina puella* Davis singing in a cedar near the road. It was located by its song and taken with a net.

Diceroprocta swalei Distant

Eleven males of *D. swalei* Dist. were taken about halfway down Yarnnell Hill, Ariz., July 2. They occurred on catclaw, cactus and other desert plants on this almost barren, boulder-covered hillside. The song was loud and varied from thirteen to twenty-three seconds in duration with a rest of ten seconds or more between songs. They frequently ceased singing when approached but could sometimes be taken with the hands when they were located.

Cacama dissimilis Distant

In the northern edge of Maricopa Co., near Hot Springs, Ariz., twelve males and ten females of *C. dissimilis* Dist., were taken July 1. They resembled *C. valvata* Uhl. very closely in the field. The song was loud and steady. The habitats here were almost exclusively Palo Verde trees and several females were observed

ovipositing in the terminal twigs which were from one-eighth to one-fourth inch in diameter. The nests occurred in series of from three to twenty and each contained six eggs placed in mismatched pairs. The eggs in several nests examined had all hatched. These nests appeared to have been made this year, yet no eggs were observed which were nearing maturation. It is possible the empty nests were made the year previous. The eggs taken shriveled.

Okanagodes gracilis Davis

O. gracilis Davis came to be a familiar part of the desert as the party journeyed south throughout Arizona to Phoenix and thence west to Yuma. The intermittent Z'---- Z'---- Z'---- of this little white cicada was loud enough to be heard by the normal ear in a moving auto. One member of the party, with slightly defective hearing, could not detect their song even when quite close to them. The cicada sings for minutes at a time when undisturbed but may cease its song or change to a more broken one when it is approached. They are not easily frightened from their perch and are taken with a net or the hands without difficulty. It occurs on any kind of desert vegetation and appears to thrive in a habitat which looks to be almost entirely dry and dead. When one has attempted to rear cicadas in captivity and failed under circumstances which seem to be favorable, one cannot help wondering how the tiny, frail nymphs ever succeed in reaching the safety of a cell and food through the mass of dry, shifting sand which surrounds these desert plants, or how an adult, so dependent upon plant juices for food, can find enough sap in a desiccated sage bush to sustain life. But here they were in abundance from Hot Springs to Phoenix and from Phoenix to Yuma singing happily in the sun, when the temperature was 122 degrees in the shade. The excellent protective resemblance may account for the fact that only two females were taken with sixty-three males. One other was observed on a stem about three inches from a male but flew before she could be taken. The color varies from almost white to greenish and tan with dark markings. July 24, this species was heard singing on the white barked shrubs near Palm Canyon south of

Palm Springs, Calif. The heat was excessive and the vegetation typical of the arid regions. Only three males were taken here.

Although *O. gracilis* Davis was collected in several localities when large broods were out, no nests were found.

Okanagana nigriviridis Davis

En route to San Diego from Yuma the party camped, July 4, under some large live oak trees near the highway between Jacumba and Buckman Springs. The country is rough and the hillsides densely covered with manzanita, small oak, etc. In this locality five species of *Okanagana* were taken and two species of *Clidophleps*. None of them occurred in large numbers. The vegetation was dense and most of the songs were of short duration so that only a few specimens of each species were obtained.

The brilliant *O. nigriviridis* Davis was caught while singing in the shrubbery both in the forenoon and evening. Its song was of sufficient duration to enable the collectors to locate it while it sang. The second beat of its song was accented thus: M-ee', M-ee'. Two males and one female were taken.

Okanagana rubrovenosa Davis

One specimen of *O. rubrovenosa* Davis was taken with a net, July 4, while sweeping manzanita. Two others were located by their song.

Okanagana mariposa Davis

Four of these large males were located singing in oak, July 4, at 5 P. M. The song was loud and continuous but the specimens were wary and difficult to take.

Okanagana vanduzei (Dist.)

O. vanduzei (Dist.) sang faintly, leading one to think it was still distant when it was close at hand. Its song was noted both morning and afternoon. Five males were taken in this locality, August 4. Eighteen specimens were taken at Winters, California, August 6. Its song was heard occasionally throughout the morning and early P. M., but the specimens were located with difficulty due to the fact that the song ceased when the

collector approached. Even when located they frequently flew before they could be taken and in most cases flew high and entirely out of range. The song was high-pitched and persistent when not disturbed.

Okanagana tristis var. *rubrobasalis* Davis

In San Diego Co., one male of *O. tristis* var. *rubrobasalis* Davis was taken July 4. The song of this species is much louder than *vanduzeei* but somewhat similar to it. The louder song caused the collector to think he was immediately upon the specimen when he was some distance away.

Clidophleps wrighti Davis

Only two specimens, males, of *C. wrighti* Davis, were taken. These were singing at three P. M., July 5.

Clidophleps blaisdelli Uhler

C. blaisdelli Uhler, sang both in the forenoon and in the afternoon usually as autos passed along the highway. The song was coarse and of very short duration, usually ending as soon as the car had passed. Seven were collected in San Diego County.

Okanagana californica Distant

In the grass-covered clearings between the timber of pines, live oaks, and white oaks near Cuyamaca Lake, San Diego, Co., California, *O. californica* Dist. attracted attention by its song about nine A. M., July 6. The elevation was about 5,000 feet. Two specimens were taken on live oak shrubs but the other forty-seven were taken among the grasses. The song was faint. The specimens were easily taken with nets when located. About ten A. M. the party moved to the west side of the lake and collected a number of males in a grassy clearing. Soon two different members of the party were discovered each moving cautiously around and around in a small area in different parts of the field. In each case a male was singing, obviously very close by but the collectors could not locate him. Sensing the unusual in the situation the party concentrated on one spot and began a determined search for the elusive singer. He was finally located

singing in a hole in the ground. When disturbed he backed down the hole. Excavation revealed a vertical tunnel about six inches deep with the matured male and his discarded exuvium at the bottom. Subsequently, numerous similar instances were found. Sometimes the emergence hole was large enough to admit the escape of the adult, sometimes it was too small for either the adult or nymph to have passed. In some cases the opening was obscured. Always when an adult was found singing in the ground, his exuvium was found at the bottom of a tunnel six to nine inches in depth either placed vertical or slanting. At eleven A. M. the party moved to another clearing covered with green grass. A number of cicadas were singing here but not one was located above ground. No exuvia were found above ground in any of the localities.

This species was collected again eight miles north of Huntington Beach, July 17, on an uncultivated flat covered with weeds and grasses. The vegetation was almost brackish in appearance. The cicadas were singing here about noon either sitting on weeds and grasses or in the ground. In both localities the song was persistent and the male fairly easily located and taken. When one was frightened, however, it usually flew high and to another part of the field. Out of a total of seventy specimens only two were females.

Clidophleps distanti Van Duzee

Clidophleps distanti Van D. was first heard singing along the highway a few miles northeast of San Diego, July 8, in a habitat of chaparral similar to that where *C. blaisdelli* Uhl. was taken. The song seemed too loud for so small a cicada. It was of very short duration apparently stimulated by the passing of cars.

July 9, at Alpine, Calif., a man said twigs of the trees in his young orchard looked as though they had been sewed on a sewing machine. Inspection showed the twigs to be filled with nests of *C. distanti* Van D. As many as ninety nests placed in a straight line were counted in a length of one and a half feet of twig. The punctures extended just under the bark raising it enough to form the nest. Twelve eggs were placed in pairs in each nest. Peach, plum, cedar and citrus trees were used as hosts. When the host withered the eggs shriveled.

Cacama crepitans Van Duzee

As the party moved northward from San Diego, July 14, along highway 101, within sight of the ocean much of the way, a large brood of *Cacama crepitans* Van D., was discovered. Near Oceanside, California, with this persistent singer rendering a noisy chorus, a half hour was spent about noon collecting a large series on a cactus covered hillside. The continuous song and the tameness of these adults made them easily located and taken with nets. The tip of the abdomen was raised gradually as the song increased in intensity and rate of vibration, and was lowered as the song decreased. A female was observed ovipositing in the stem of a dead weed about one-eighth inch in diameter. She had placed four large white eggs almost in single file in a nest. The nests were so close together that they made almost a continuous line of eggs down the pithy center. This series contained eight nests. Eleven days later these eggs were in good condition. It seems probable they would develop and hatch in the laboratory just as the eggs of *C. valvata* Uhl. did.

This species was out in numbers also on the desert hills surrounding Irvine Park ten miles northeast of Santa Ana, California. They sang persistently from eight thirty in the morning until one in the afternoon but did not sing at all in the late afternoon, July 15 and 16, although the sun shone brightly.

Okanagana consobrina Distant

O. consobrina Dist. was first heard, July 21, singing along the roadside near the Rangers cabin twelve miles north of Idlewild, California. Two males were located by their song about noon and captured. They sang continuously but were so wary that they were taken with difficulty even when located. Eighteen males and three females were later taken at Winters, and near Sacramento, California. In both latter localities they were less wild. Great variation in color was noted among the adults taken near Sacramento. A cage was formed from mosquito netting over a large green weed containing many nests of cicada eggs which were thought to be laid by this cicada. A light colored male and dark colored female were placed in this cage in the hopes that some data might be obtained on the mating of dis-

similar colored specimens. The males sang almost incessantly throughout the afternoon during the fifty-mile drive and while the car was stopped at various times. No data were obtained on copulation.

The nests in the weed were an interesting study. Three freshly made nests were thought to have been made by the female in captivity. In these the eggs were white. The older nests were in series of from two to twenty-one. The nests usually contained eight eggs. Most of these eggs were pink with dark eye spots plainly visible.

Okanagana pallidula Davis

O. pallidula Davis occurred in great numbers south of Bakersfield, California, July 24, in large patches of a light-colored bushy weed, from a foot to two feet tall, which were growing near the highway. The cicadas were very numerous on this weed and many exuvia were found clinging to clods in a nearby field. The males sang persistently and were easily taken with nets. One male was located singing in the ground just as specimens of *O. californica* were found. The adult was taken three inches below the surface and the exuvium was found down about two feet.

Again, on August 1, this species was singing along the highway both south and north of Merced, California. Several specimens were taken in the short grass covering the airport northwest of town. It was also very common at Winters, California.

Okanagana utahensis Davis

In the same locality near Bakersfield, California, where *O. pallidula* Davis was collected, three males of *O. utahensis* Davis were taken. The song of this species is much louder than that of *pallidula*. The brood here was very small and only a few males were heard.

Clidophleps pallida Van Duzee

C. pallida Van D. was first heard at Lemon Cove, California, July 26, singing in a grape vineyard. Later in the evening it sang in the live oak trees in a camp site near a stream east of

Three Rivers. Frequently, en route to the Giant National Forest, the short, harsh, song of this elusive cicada would bring the party to a halt only to cease before any one could locate the singer. Its song was heard frequently up to 4,000 feet elevation and it was thought probable that it was this species which was heard once at 5,000 feet elevation in the edge of the Giant Forest. It was not until the party was descending the mountain road from the Park toward Three Rivers, however, and stopped to collect, a few hundred feet above a construction gang who were using a large truck in building the new road, that the collectors succeeded in taking any of this species. Its song is of very short duration, stimulated undoubtedly by the sound of a running motor or by the song of other males of its species. It was almost impossible to locate them by their song because of its brevity but frequently one could follow the short clucks which are often made at intervals between songs. This cluck resembles, somewhat, that frequently made by birds. This habit of clucking between songs seems to be typical of many species of Clidophleps, but in this species the sounds are a little farther apart and continued over a longer period than most of the others observed. Some of the specimens were taken with nets, some shot, and some taken with fingers after climbing a tree to reach them. One pair was observed mating, and taken in the latter manner about fifteen feet above ground. Song was noted from eight A. M., until night.

This song was heard occasionally at Winters, California, and three specimens were secured with difficulty.

Okanagana tristis Van Duzee

In the same habitat where *C. pallida* Van D. was first taken occurred the persistent singer *O. tristis* Van D. The vegetation was so dense that several specimens were frightened away before they could be located. Only one male was taken. When the singing male is approached, he ends his song in a series of fluttery clicks.

Okanagana rimosa Say

One male specimen of *O. rimosa* Say was shot while it was singing in a pine tree near the highway west of Carson City,

Nev., August 8. Its song was rather low pitched and loud, and continued for several minutes.

In view of the fact that over 800 specimens had been taken on the first part of the trip it is interesting to note that only four were collected after the party left Lake Tahoe, California, although they were especially sought. Exuvia were found occasionally and also nests of mature eggs. These eggs were pink and showed red eyespots and tarsal claws. One adult was heard at Beaver, Utah, but eluded the collectors. The scant evidence seemed to indicate that the cicadas in the high altitude of Utah, Nevada, and Colorado appear early in the season and the eggs mature and hatch before winter.